Multifunctional recyclable monomers from 1,2-dithiolanes

As additive manufacturing technologies continue to advance, the recycling of printed components remains a major challenge. Thermosets remain the material of choice in light-driven additive manufacturing due to their fast gelation kinetics and stability after crosslinking, however, their permanently crosslinked structure restricts recycling or remolding unless dynamic bonds are present. Covalent adaptable networks (CANs), which incorporate dynamic crosslinks into polymer networks, offer a promising solution for creating recyclable or remoldable thermosets. Recently, 1,2-dithiolanes, a cyclic disulfide, have gained renewed interest for use in polymer systems as a dynamic chemistry. Dithiolanes undergo ring-opening polymerization, resulting in linear disulfides and enabling the formation of CANs directly through crosslinking. In this study, we introduce a tetrafunctional dithiolane monomer, lipoic acid pentaerythritol ethoxylate, which can be photopolymerized and is compatible with high-resolution light-based additive manufacturing across multiple length scales. Additionally, this monomer can depolymerize back to its original ring-closed form through heating and solvent dilution, allowing for repolymerization. This work represents a significant advancement in the development of multifunctional dithiolane monomers and recyclable resins for additive manufacturing.